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ORIGINAL ARTICLE

Transanal endoscopic microsurgery for radical resection of sigmoid cancer

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Summary

Purpose: *This study aimed to investigate the efficacy and safety of transanal endoscopic microsurgery for radical resection of sigmoid cancer.*

Methods: *91 patients with sigmoid cancer who underwent sigmoid cancer resection were divided to the Control Group (43 patients who underwent conventional laparoscopic surgery and pathological specimens were taken through the abdomen) and the Study Group (48 patients who were subjected to transanal endoscopic microsurgery and pathological specimens were taken through the anus). Comparisons were made about the operation time and the amount of surgical bleeding of the two groups, as well as the postoperative exhaust time and postoperative visual analogue score (VAS) of the two groups. Also, factors like the complications, postoperative hospitalization time, additional analgesic treatment, and treatment efficacy of patients within the first month after the surgery were compared between the two groups. Finally, a 3-year follow up for patients was performed to record the 3-year recurrence rates.*

Results: *The operation time and the amount of surgical bleeding of the Study Group were significantly lower than those of the Control Group ($p<0.05$); the 3-year recurrence rate of the Study Group was lower than that of the Control Group. On the contrary, the 3-year survival rate of the Study Group was significantly higher than that of the Control Group ($p<0.05$).*

Conclusion: *The application of transanal endoscopic microsurgery for radical resection of sigmoid cancer is worthy of clinical promotion despite its high technical requirements for the surgeon and certain degree of promotion difficulty, since it boasts high effective rate, low rate of complications, and the contribution for decreased recurrence rate and improved survival.*

Key words: *anal endoscopic microsurgery, sigmoid cancer, effectiveness, safety analysis*

Introduction

As a common malignant tumor among digestive system tumors, sigmoid colon cancer, with its recently increasing incidence rate, is greatly threatening human life as many patients cannot get a timely correct diagnosis until the advanced stages due to its few symptoms in the early stages [1]. As one of the colon cancers, sigmoid colon cancer is commonly treated by surgery. Considering the big trauma and great impact on the quality of life of patients after the traditional open surgery, the search for a suitable surgical method that has less trauma on patients is of great clinical significance [2].

When surgical treatment is performed in patients with colorectal cancer, prior consideration

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should include how to possibly maximize the protection of the normal function of the intestinal tract and thus minimize the damage to the intestinal tract [3]. With minimally invasive techniques stepping into a more advanced stage, transanal endoscopic microsurgery (TEM), a method of minimally invasive and sphincter-preserving surgery combining three advanced technologies including endoscopy, laparoscopy, has got constant improvement and been widely applied clinically, earning recognition from most doctors and patients with its good clinical efficacy [4,5]. Studies have shown that TEM can provide a better view of tumor exposure during surgery, and can perform an accurate resection of tumors 4 to 8 cm away from the anal margin [6]. Compared with the traditional laparoscopic resection, TEM can not only bring better efficacy but also bring specimens of higher quality for pathological diagnosis, which is of great importance for accurate pathological staging and the following treatment [7]. At present, TEM has been widely recognized for its efficacy and safety in treating early rectal cancer and benign rectal tumors [8]. Studies have revealed that the recurrence rate of rectal cancer after TEM resection at T1 tumor stage is only 0-13%, while the recurrence rate of rectal cancer after conventional anal partial resection at T1 tumor stage can reach 5-40% [9,10]. Some studies also confirmed the safety and efficacy of TEM resection when exploring the resection of

Table 1. General clinicopathological data

Data	*Study Group n=48 n (%)*	*Control Group n=43 n (%)*	x^2	*p*
Gender			0.033	0.856
Male	27 (56.25)	25 (58.14)		
Female	21 (43.75)	18 (41.86)		
Age, years			0.040	0.842
≥60	30 (62.50)	26 (60.47)		
<60	18 (37.50)	17 (39.53)		
BMI (kg/m^2)			0.008	0.930
≥22	25 (52.08)	22 (51.16)		
<22	23 (47.92)	21 (48.84)		
TNM stage			0.008	0.930
I	23 (47.92)	21 (48.84)		
II	25 (52.08)	22 (51.16)		
Distance between the tumor and the anal border (cm) (mean±SD)	18.4±1.1	18.3±1.3		
Alcohol abuse			0.032	0.859
Yes	31 (64.58)	27 (62.79)		
No	17 (35.42)	16 (37.21)		
Coagulation function (mean±SD)				
APTT s	28.66±2.57	28.72±2.63	0.11	0.913
PT s	11.82±1.05	11.91±0.97	0.423	0.673
FIB g/l	3.11±0.25	3.12±0.24	0.194	0.847
TT s	14.51±1.57	14.62±1.61	0.330	0.742
Tumor differentiation			0.049	0.825
High	29 (60.42)	25 (58.14)		
Moderate	19 (39.58)	18 (41.86)		
Liver function indices (mean±SD)				
Serum total protein (g/L)	72.14±2.33	71.98±2.45	0.319	0.750
Glutamic pyruvic transaminase (μmol/L)	26.05±4.11	26.12±4.09	0.081	0.935
Total bilirubin (μmol/L)	11.31±2.15	11.16±2.17	0.331	0.742
Renal function index (μmol/L), mean±SD				
Creatinine	67.26±4.15	67.36±4.11	0.115	0.909
Urea	5.81±0.77	5.76±0.82	0.300	0.745
Uric acid	288.44±13.23	287.12±13.42	0.455	0.650

large rectal polyps by TEM [11]. However, few studies were reported on the application of TEM in the radical resection of sigmoid colon cancer which is currently mostly treated with laparoscopic surgery -a method that is suggested by many studies to be with similar efficacy to open surgery [12].

In order to seek a better surgical treatment for patients with sigmoid cancer, this study analyzed the efficacy and safety of transanal endoscopic microsurgery for the radical resection of sigmoid cancer. Specific research methods were as follows.

Methods

General information

A retrospective analysis was made of 91 patients with sigmoid colon cancer who underwent radical disease resection in the First Hospital of Changsha, including 52 males and 39 females, with an average age of 61.5±10.3 years, 44 with T1 tumor stage and 47 with T2 tumor stage. Forty-three patients who underwent conventional laparoscopic surgery had pathological specimens taken through the abdomen were enrolled in the Control Group; 48 patients who underwent transanal endoscopic microsurgery had pathological specimens taken through the anus and were included in the Study Group, the two groups being comparable without significant difference in terms of gender, age, body mass index (BMI) and tumor staging ($p>0.05$) (Table 1). Inclusion criteria included: patients pathologically diagnosed with sigmoid colon cancer; exclusion criteria included: patients with severe liver and kidney dysfunction; patients with other severe organ diseases or patients with sigmoid colon cancer complicated with other tumors; patients with surgical contraindications; patients with poor tumor differentiation; patients with advanced sigmoid colon cancer unsuitable for TEM surgery; patients with cognitive and communication impairment; patients no cooperative for the treatment and examinations.

This study was approved by the ethics committee of the hospital and all patients and/or their families signed the informed consent form.

Introduction to TEM surgery system

The TEM system is mainly composed of three parts: its unique proctoscope, special surgical instruments, and the imaging system which were all purchased from Richard Wolf GmbH. The TEM proctoscope can be fixed on the operating table, with an outer diameter of 4cm and an axial length of 12 or 20cm. The camera lens can be connected with the image monitor through the channel on the TEM proctoscope operation panel, which can display a clear three-dimensional surgical view magnified by 3 to 6 times.

Surgical methods

Before the operation, a TEM team was formed, all members of which were professionally trained to perform the operation and troubleshooting of the instruments with mastery and proficiency. First, for preoperative preparation, all patients were banned from eating and drinking during the night before surgery, and antibiotics were used in patients in advance to prevent infection. Preoperative routine toweling was conducted after entering the operating room. Intraoperative general anesthesia was performed using the supine legs position, and the urinary catheter was inserted from the urethra. Patients in the Control Group underwent a routine laparoscopic surgery and the pathological specimens were taken from the abdomen. Patients in the Study Group were subjected to transanal endoscopic microsurgery and the pathological specimens were taken through the anus.

The specific steps were as follows: Firstly, the various matching devices of the TEM proctoscope pump were properly connected; afterwards, the anus was gently expanded with the help of fingers; following that, the rectosigmoid was dissociated by the laparoscope and cut in the abdominal cavity, and the TEM lens shell was inserted into the anus; next, the sigmoid colon was pulled out together with the tumor from the anus through the TEM lens shell, and the sigmoid colon containing the tumor was cut off along with the corresponding mesentery and lymph nodes at 10 cm away from the upper end of the tumor. Then, external purse-string suture was used on the remaining sigmoid colon stump. The resected sigmoid tumor specimens were placed in formaldehyde solution and sent quickly for pathological staging diagnosis. After the anesthesia recovery, patients were encouraged to move to the ground as soon as possible and were advised to take little fluid food in the first postoperative day.

Observation indicators

Firstly, the operation time and the amount of surgical bleeding, as well as the postoperative exhaust time and postoperative VAS score [13] of the two groups were recorded and compared; then, the length of the bowel resection, the size of the resected tumor, and the number of resected lymph nodes were compared between the two groups. In addition, factors including the rate of complications, the postoperative hospitalization time, the additional analgesic treatment, and the treatment efficacy within the first postoperative month were compared between the two groups. The treatment efficacy was divided into three categories: significant efficacy, certain efficacy and little efficacy, and the total effective rate of treatment was defined as (number of patients with significant efficacy+number of patients with certain efficacy)/total number of patients in the group x100%. A 3-year follow up was performed to record and compare the recurrence and survival rates of the two groups and to draw the survival curve.

Statistics

In this study, the data were statistically analyzed using the SPSS 20.0 software (Bizinsight, Beijing Information Technology Co., Ltd.); all the graphs in this study were drawn using GraphPad Prism 6 software; the count data were compared with the chi-square test; the meas-

urement data were expressed using mean±standard deviation. Comparison of the survival rate was performed using the log rank test. Survival curves were drawn using the Kaplan-Meier method. Statistical difference was recognized if p<0.05.

Results

Comparison of the operation time and the amount of surgical bleeding between the two groups of patients

The operation time of the Study Group was 67.31±16.91 min, significantly shorter than that of the Control Group (128.35±21.76 min) (p<0.05). The amount of surgical bleeding of the Study Group (12.76±6.29 ml) was statistically significantly lower than that of the Control Group (35.61±9.88 ml) (p <0.05). More details are shown in Table 2.

Comparison of the postoperative exhaust time, VAS score on the first day after the surgery, and the postoperative hospitalization time between the two groups

The postoperative exhaust time of the Study Group was 38.21±25 min after the surgery, significantly lower than that of the Control Group (58.32±9.27 min after surgery) and the difference was statistically significant (p<0.05); the postoperative VAS score of the Study Group was 2.11±0.23, which was considerably lower than that of the Control Group (4.68±0.85) (p<0.05); the postoperative hospitalization time of the Study Group was 3.45±1.12 days, greatly lower than that of the Control Group (6.84±0.76 days) (p<0.05) (Table 3).

Information of the surgical resection specimens of the two groups of patients

No significant difference was detected between the two groups in terms of the length of the bowel resection, the size of the resected tumor, and the number of resected lymph nodes (p>0.05), while the negative resection margin rate of the Study Group was statistically significantly higher than that in the Control Group (p<0.05) (Table 4).

Complications within the first postoperative month in the two groups

The Study Group had a complication incidence rate of 6.25%, including 2 cases of anal hemorrhage after the operation with a bleeding volume of about 50-80 ml, and 1 case of pulmonary infection which was improved after the anti-infective treatment. The Control Group had a complication incidence rate of 32.56%, including 6 cases of anal hemorrhage with a bleeding volume of 60-100 ml, 5 cases of pulmonary infection, 2 cases of anal incontinence, and 1 case of anastomotic leak. The Study Group had a much lower incidence rate of

Table 2. Comparison of the operation time and the amount of surgical bleeding between the two groups of patients

Factors	*Study Group, n=48 mean±SD*	*Control Group, n=43 mean±SD*	*t*	*p*
Operation time (min)	67.31±16.91	128.35±21.76	15.02	<0.001
Amount of surgical bleeding (ml)	12.76±6.29	35.61±9.88	13.30	<0.001

Table 3. Comparison of the postoperative exhaust time, VAS score on the first postoperative day, and the postoperative hospitalization time between the two groups

Factors	*Study Group, n=48 mean±SD*	*Control Group, n=43 mean±SD*	*t*	*p*
Postoperative exhaust time (min)	38.21± 6.25	58.32± 9.27	12.24	<0.001
VAS score	2.11± 0.23	4.68± 0.85	20.15	<0.001
Postoperative hospitalization time (d)	3.45±1.12	6.84±0.76	16.70	<0.001

Table 4. Information of the surgical resection specimens of the two groups of patients

Factor	*Study Group, n=48 mean±SD*	*Control Group, n=43 mean±SD*	x^2	*p*
Length of bowel resection	18.56± 4.23	19.11± 4.68	0.589	0.557
Tumor size	4.67± 1.09	4.25± 1.13	1.804	0.075
Number of resected lymph nodes	16.66±2.99	16.05± 3.12	0.952	0.374
Negative resection margin, n (%)	46 (95.83)	35 (81.40)	4.834	<0.050

Table 5. Complications within the first postoperative month in the two groups

Complications	*Study Group, n=48* *n (%)*	*Control Group, n=43* *n (%)*	χ^2	*p*
Anal hemorrhage	2 (4.17)	6 (13.95)	-	-
Pulmonary infection	1 (2.08)	5 (11.63)	-	-
Anal incontinence	0	2 (4.65)	-	-
Anastomotic leak	0	1 (2.33)	-	-
Incidence rate	3 (6.25)	14 (32.56)	10.33	<0.050

Table 6. Sample crushing rate and postoperative analgesic treatment in the two groups of patients

Factors	*Study Group, n=48* *n (%)*	*Control Group, n=43* *n (%)*	χ^2	*p*
Sample crushing rate	2 (4.17)	8 (18.60)	4.834	<0.050
Rate of analgesic treatment	1 (2.08)	11 (25.58)	10.94	<0.050

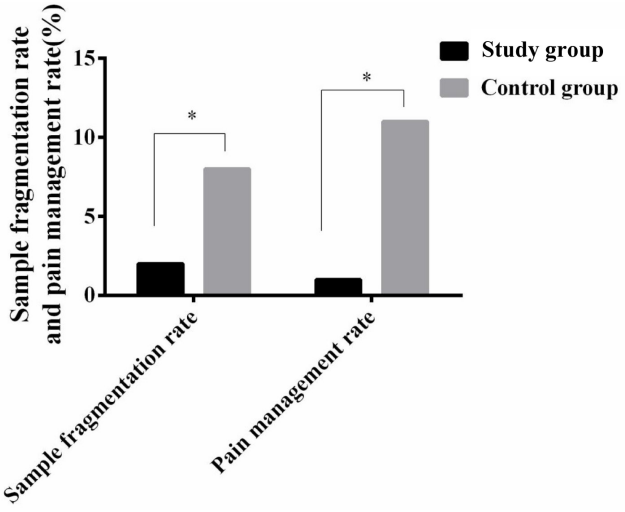

Figure 1. The sample crushing rate and postoperative analgesic treatment rate of the two groups of patients. The sample crushing rate of the Study Group was significantly lower than that of the Control Group, and the difference was statistically significant (*p <0.05). The Study Group had a lower analgesic treatment rate than the Control Group (*p<0.05).

complications than the Control Group, and the difference was statistically significant (p<0.05) (Table 5).

Sample crushing rate and postoperative analgesic treatment in the two groups of patients

The sample crushing rate of the Study Group was greatly lower than that of the Control Group -a sample crushing rate of 4.17% in the Study Group with 2 broken samples and a sample crushing rate of 18.60% in the Control Group with 8 broken samples, and the difference was statistically significant (p<0.05). The rate of analgesic treatment of the Study Group was 2.08% (with only one patient receiving follow-up analgesic treatment), much lower than that of the Control Group (25.8%, with follow-up analgesic treatment performed on 11 patients). The difference was statistically significant (p<0.05) (Table 6 and Figure 1).

Comparison of the total effective rate of treatment between the two groups of patients

The Study Group had a total effective rate of treatment of 95.83%, with 36 patients achieving significant efficacy, 10 patients achieving certain efficacy, and 2 patients achieving little efficacy. The total effective rate of treatment of the Control Group was 81.40%, including 25 patients enjoying significant efficacy, 10 patients enjoying certain efficacy, and 8 patients with little efficacy. The total effective rate of the Study Group was significantly higher than that of the Control Group, with statistically significant difference between the two groups (p<0.05) (Table 7).

Recurrence and survival of the two groups within the first 3 years after surgery

The Study Group had a recurrence rate of 6.25% with 3 cases of recurred cancer within the first 3 years after surgery, greatly lower than that of the Control Group which had a recurrence rate of 30.23% with 13 reports of recurred cancer within the first 3 years after surgery, and the difference was statistically significant (p<0.05). The 3-year survival rate of the Study Group reached 89.5% with 5 deaths within the 3 years (3 died of tumor recurrence and metastasis and 2 died of other causes, like myocardial infarction), while the 3-year survival rate of the Control Group was 72.09% with 12 deaths within the 3 years (8 died of tumor recurrence and metastasis, 1 died of anastomotic leak,

Table 7. Comparison of the total effective rate of treatment between the two groups of patients

Treatment efficacy	*Study Group, n=48* *n (%)*	*Control Group, n=43* *n (%)*	x^2	*p*
Significant efficacy	36 (75.00)	25 (58.14)	-	-
Certain efficacy	10 (20.83)	10 (23.26)	-	-
Little efficacy	2 (4.17)	8 (18.60)	-	-
Total effective rate	46 (95.83)	35 (81.40)	4.834	<0.050

Table 8. Recurrence and survival of the two groups within the first 3 years after surgery

Factors	*Study Group, n=48* *n (%)*	*Control Group, n=43* *n (%)*	x^2	*p*
Recurrence rate	3 (6.25)	13 (30.23)	9.002	<0.050
Survival rate	43 (89.58)	31 (72.09)	4.567	<0.050

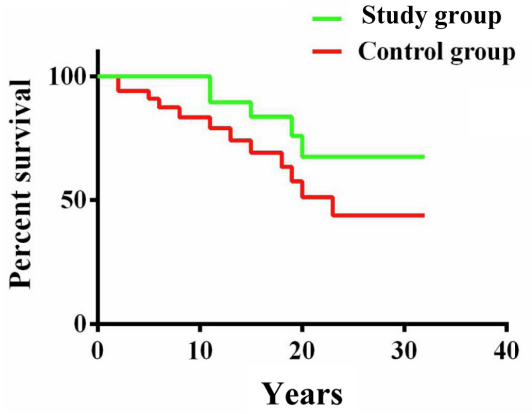

Figure 2. Comparison of the 3-year survival rate between the two groups. The 3-year survival rate in the Study Group was 89.58% (5 patients died within the first 3 years after the surgery), greatly higher than the 3-year survival rate of 72.09% in the Control Group (12 patients died within the first 3 years after the surgery), and the difference was statistically significant (p<0.05).

and 3 died of other causes). The 3-year survival rate of the Study Group was significantly higher than that of the Control Group, and the difference was statistically significant (p<0.05) (Table 8 and Figure 2).

Discussion

Cancer of the sigmoid is a clinically common malignant tumor of the digestive tract with a high incidence rate, second only to gastric cancer and esophageal cancer [14]. For long, laparoscopic surgery has substituted open surgery, becoming the main treatment for colon cancer patients. However, with the continuous development of minimally invasive techniques, the surgical method has gradually developed from abdominal open surgery to surgery using natural lumens, in pursuit of reduced trauma and pain of patients [15]. TEM, an endoscopic minimally invasive surgery through the anus, belongs to the natural orifice of transluminal endoscopic surgery (NOTES) which has main approaches through the vagina, urethra and anus [16], and its effectiveness and safety as a surgical micro-innovation technique has been confirmed by a previous study [16]. TEM is a common treatment in early rectal tumors [17] and has been reported to be curative for other diseases such as rectal carcinoid without extraintestinal infiltration and rectal GIST [18,19]. Considering the few studies on the application of TEM in sigmoid cancer, this study collected and compared the clinical data of patients with sigmoid cancer treated by conventional laparoscopic surgery and TEM, in order to investigate the efficacy and safety of TEM for the surgical resection of sigmoid cancer.

First, the operation time and the amount of surgical bleeding of the two groups were compared, revealing a much shorter operation time and much lower amount of surgical bleeding in the Study Group than those in the Control Group, with a statistical difference between the two groups (p<0.05). These results indicated that the application of TEM can effectively shorten the operation time and reduce the amount of surgical bleeding of patients compared with the traditional laparoscopic surgery, which might be contributed to the time reduction of direct access into the intestinal tract while the look for lesion and the suture in the laparoscopic surgery were heavily time-consuming. Then, the postoperative exhaust time, hospitalization time, and VAS score on the first postoperative day in the two groups were compared, showing that the Study Group had a shorter postoperative exhaust time, lower postoperative VAS score, and shorter postoperative hospitalization time than the

Control Group, and the differences were statistically significant (p<0.05). Such results confirmed the advantages of TEM to significantly shorten the postoperative exhaust time and hospitalization time of the patient, and to certainly relieve the patient's postoperative pain. Also, the complications, sample crushing rate and postoperative analgesic treatment of the Study Group were improved compared to the Control Group in which patients suffering from anastomotic leak after the laparoscopic surgery died of infections and their prognosis was poor after the emergency rescue, with a statistically significant difference (p<0.05). In a study [20] which explored the efficacy and safety of TEM and traditional anal endoscopic surgery for rectal tumors, TEM was proved to bring less bleeding, fewer complications, and lower recurrence rates, which was explained as a result of a more accurate operation and more complete hemostasis with TEM. Such a study can prove and explain the findings of this study. Another study [21] pointed out that TEM has a very small systemic effect on patients due to its precise operation and minimal wound, which results in a lower incidence of complications with just some minor complications if they occur. According to the comparison of the surgical specimens of the two groups of patients, there was no significant difference in the length of bowel resection, tumor size, and the number of resected lymph nodes between the two groups (p>0.05), which suggested a similar resecting effect for tumors between the ordinary laparoscopic surgery and the TEM; however, the two groups were statistically different in terms of the negative resection margin, with much higher negative resection margin rate in the Study Group than that in the Control Group (p<0.05). Finally, the treatment efficacy, the 3-year recurrence rate, and the 3-year survival rate of the two groups were compared, confirming that the Study Group had a much higher total effective rate, a greatly lower 3-year recurrence rate and 3-year mortality rate than the Control Group, and the differences were all statistically significant (p<0.05). One study [22] has shown that the risk of re-appearance of rectal cancer is related with the negative resection margin rate and the tumor size, without significant relation to other factors, which guided the speculation of this study that the low recurrence rate of patients after TEM treatment is a result of the TEM's low negative resection margin rate. One previous study [23] stated that, regardless of the tumor size and tumor location, the postoperative recurrence rate of TEM in the treatment of rectal adenomas was significantly lower than that of the conventional rectal anal canal resection, and that TEM can also bring good efficacy for distal rectal cancers. One study [24] holds the opinion that patients with T1 tumor stage are more likely to be cured with TEM, while some others [25] believe that patients with T2 tumor stage can also get satisfying efficacy from TEM if neoadjuvant therapy is performed before the local resection. This study did not evaluate the efficacy of TEM on patients with different stages, waiting for a further follow-up study.

In summary, compared with the conventional laparoscopic surgery, the transanal endoscopic microsurgery in the resection of sigmoid cancer is worthy of greater clinical promotion despite its high technical requirements for the surgeon and certain degree of promotion difficulty, since it boasts high effective rate, low rate of complications, and the contribution for decreased recurrence rate and improved survival. In this study, limitations like the small number of research samples made it unavailable to analyze the influence of different tumor stages and pathological factors on the efficacy and safety of TEM. This calls for an expanded number of research samples to collect more accurate and more rigorous clinical evidence for a better program for the treatment of sigmoid cancer.

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Conflict of interests

The authors declare no conflict of interests.

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